

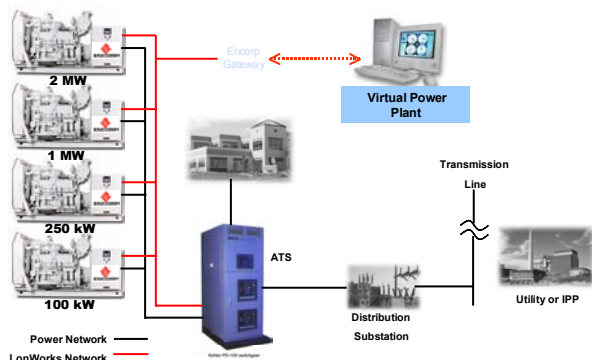
The Gas Technology Institute and Encorp Inc.

Innovative Interconnection and Control Systems

Goals

A modernized electric utility grid capable of advanced operations can serve our requirements for reliable and cost-effective energy. One way to achieve this is through distributed power (DP) systems interconnected with the grid and integrated with energy management systems. Intelligent solutions that incorporate high-value technology, information exchange, and technical services provide interoperability, flexibility, and operational robustness among DP, the grid, and loads.

The Gas Technology Institute (GTI), in partnership with Encorp Inc., is developing innovative interconnection and control systems for DP implementation. It is developing key enabling hardware, control logic, and communications capabilities; combining them to build system-level integrated solutions; and demonstrating and validating them using conventional and emerging DP technologies and products.



Conceptual representation of DP configuration

The goals of the project are to:

- Develop cost-effective DP interconnection products, software, and communications systems to improve the economics of a range of DP systems
- Enhance the capabilities of DP products to provide benefits to the electric power system and advanced building energy management systems through integration and interaction.

To accomplish these goals, Encorp is developing technologically enhanced devices such as an advanced controller, a power sensor module, and revenue-grade meters. It is also developing

communication capabilities. These were included in a DP systems interconnection demonstration and will be further tested in future demonstrations.

Results

Advanced Controller

GTI and Encorp are developing an enhanced core controller to serve the emerging DP market. The controller is designed to be flexible and expandable to meet the needs of small and large distributed generators. Because it is designed to accept several pulse inputs, it can integrate and interface with multiple DP systems and revenue-grade meters. The controller improves DP economics by lowering interconnection costs while providing added features and performance. This is being accomplished in accordance with industry standards.

Power Sensor Module

The power sensor module (PSM) is a standalone intelligent module powered by high-power digital signal processor technology. The purpose of the PSM is to interface with multiphase voltage and current transformer inputs. The PSM will perform extensive signal processing and data management and provide resulting values to the controller module. This module will contain relay outputs, digital inputs, solid-state digital outputs, and software to perform several protective relay functions.

The protective relay functions fully comply with IEEE 1547 requirements. Further, the PSM will be able to incorporate additional protective functions as needed for specific design applications.

Communication Capabilities

A critically important element of this project is the incorporation of an expanded set of communication capabilities that includes communication pathways to intertie with existing and future energy management systems, electric utility command and control centers, independent system operators, regional transmission operators, and other participants.

The controller needs to incorporate enough flexibility to accommodate historic communication protocols and practices as well as new developments. Encorp has identified communications capabilities that will allow interface with higher-level systems for monitoring, analysis, dispatch, and metering.

Revenue-Grade Meter Interface

It is important to incorporate features common to the most widely used electric demand meters while allowing for innovation in the development of revenue-grade meters. Encorp has developed a meter interface that can receive signals from Form C relays (also known as KYZ relays). A Form C relay changes state with each rotation of an electric demand meter disk. This output can be read by the interface, and the energy use can be extrapolated from the number of meter relay state changes.

Interconnected DP Device Demonstration

To establish, through firsthand experience, the interconnection and communications issues of DP systems, a case study was done at the Chowchilla II power generation station in Chowchilla, California. The Chowchilla II plant is a 25-MW facility powered by 16 Duetz natural gas-fueled generator sets operated in parallel with the local utility.

Encorp designed the controls and switchgear system for this plant. The demonstration included prototypes of some of the features incorporated in the advanced controller. This prototype hardware was not integrated in the same manner as planned for the production advanced controller, but it modeled the capabilities that are to be integrated into it.

Individual generator measurements were passed to the communications processing modules in each system, which passed them to remote monitoring and control facilities where the generators were controlled.

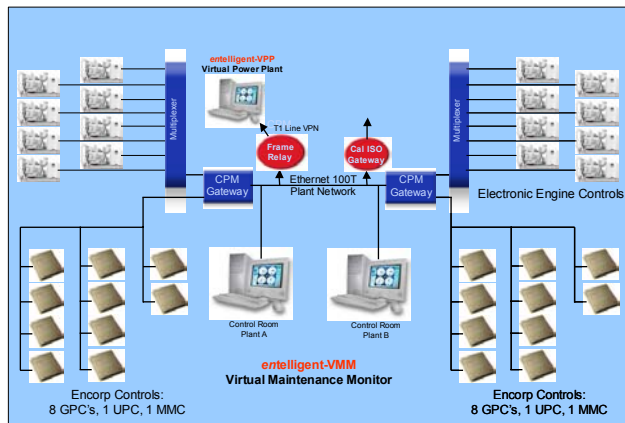


Diagram of Chowchilla's communication architecture

The resultant work has achieved the following prototype advances:

- A 20-fold performance improvement through use of a high-speed controller central processing unit and a high-speed digital signal processing chip
- A 40% reduction of the controller footprint/volume
- Reduced customer installation and maintenance costs through improved packaging and a simplified strategy for wiring terminals and connectors

- Projected manufacturing cost savings of 15%–20%
- Increased control capabilities through the design of an anti-islanding control scheme and a loss-of-synchronization control scheme
- Overall grid interconnect system capital and installation cost savings through the elimination of added system hardware that is now intrinsic to the advanced controller (i.e., improved firmware and communications capabilities)
- Increased design flexibility for compliance with current and projected industry standards for switchgear and interconnection devices
- Increased functionality for the DP customer
- Demonstrated functionality (under the Chow II case study).

Publications

Liss, W.; Dybel, M. "Development of Innovative Distributed Power Interconnection and Control Systems: Annual Report." December 2000–December 2001." NREL/SR-560-32864. November 2002.

Publications are available on the NREL publications database at <http://www.nrel.gov/publications/>.

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Additional Distributed Power Information

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